

U. S. DEPARTMENT OF AGRICULTURE.

DIVISION OF POMOLOGY.

BULLETIN NO. 4.

REPORT

ON THE

RELATIVE MERIT OF VARIOUS STOCKS FOR THE ORANGE,

WITH NOTES ON

MAL DI GOMA AND THE MUTUAL INFLUENCE OF STOCK AND SCION.

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LETTER OF SUBMITTAL.

FEBRUARY 27, 1891.

SIR: I have the honor to submit herewith the following report upon the subject of stocks for orange trees. It has been prepared from reports received in answer to a circular sent to the orange growers of the United States, and the conclusions reached are based upon the testimony of a large number of those who are actively engaged in the cultivation of this fruit.

Respectfully,

H. E. VAN DEMAN,
Chief of Division of Pomology.

Hon. J. M. RUSK, *Secretary.*

INTRODUCTION.

For a number of years the question of the proper stock upon which to bud the orange has been actively discussed, but no decisive conclusions have heretofore been reached to aid an inexperienced planter in the selection of the stock upon which to found his grove. Recognizing the necessity of some guide to the subject, the Department of Agriculture, through the Division of Pomology, issued early in the current fiscal year a circular to the orange growers of Florida and Louisiana, asking for an opinion, based upon their individual experience, in regard to the merit of the several stocks in use, and particularly in regard to the sweet (*Citrus aurantium*) and sour (*C. bigaradia*) orange stocks. Numerous replies have been received, and upon them the conclusions and recommendations of the present paper are based. The author's personal views have been eliminated as carefully as possible. Circulars were not sent to California, as the introduction of the sour orange stock there is too recent to warrant a final judgment upon its value, but correspondence has been had with some of the growers in that State who have had experience in the matter.

Conclusions deduced from the reports of experienced cultivators will doubtless be considered of practical importance to those desiring to plant orange orchards, and may thus serve to lessen the cost of production of fruit, so that both grower and consumer may be benefited. The work of collating the information given in the circulars returned has been committed to and performed under my direction by Mr. William R. King, an assistant in this office. He has also added notes upon Mal di Goma and The Mutual Influence of Stock and Scion.

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H. E. VAN DEMAN.

THE RELATIVE MERIT OF VARIOUS STOCKS UPON WHICH TO BUD ORANGES.

In general terms, the question of stock resolves itself into two parts: (1) The stock suitable for strong soil, and (2) that suitable for light, sandy soil. In regard to the first there is little room for doubt or debate; in every orange-growing section where the test has been made the verdict is decidedly in favor of the sour orange stock on strong, well-watered land, particularly that classed in Florida as "hummock."* This is quite natural, since these lands are the adopted home of the wild sour orange. The superior natural vigor of the wild tree under these conditions, its freedom from disease, especially the dreaded Mal di Goma (foot rot or gum disease), and the early age at which it bears paying crops when budded, all contribute to make it popular. The reports of our correspondents have been tabulated and the summary will be discussed in detail under the different topics.

SWEET STOCK.

Under ordinary conditions the sweet seedling has long been considered the longest lived and most thrifty of the orange family, but as the foundation of a commercial grove it is now seldom thought of by progressive growers. The same reasons that have been advanced in the argument for seedling orange groves were used years ago by the advocates of seedling apple and peach orchards, and are about equally forcible. The more recent plantings are based on a more progressive principle. Every one can remember when all oranges from Florida or California were simply "Florida oranges" or "California oranges;" now we hear Washington Navel, Majorca, Jaffa, Maltese Blood, and other varieties spoken of almost as freely by orange dealers as we hear Ben Davis, Yellow Newtown, Baldwin, and York Imperial referred to by apple consumers. The sweet seedling is long lived and in the course of

* For definition of the various types of Florida land see explanatory notes on page 21.

time will make a very large tree; it is thrifty and will do fairly well on dry, thin soil where the sour orange will not succeed. A budded tree, however, is in full bearing before the seedling has more than commenced to bear; it may not make so large a tree, but it is more prolific and a greater number may be planted on an acre, facilitating the gathering of the fruit, and allowing better care. As a stock upon which to bud some standard variety, the sweet seedling will always find more or less favor. Upon the high pine lands of Florida about 30 per cent. of the growers are found to favor sweet stock (including seedlings), against 40 per cent. who favor sour orange stock, this difference of opinion being traceable to different soil conditions or to the presence or otherwise of Mal di Goma. In general terms the sweet stock is most in favor upon the poorer class of high pine land, or with growers who are not able to give the trees proper attention and sufficient fertilizer. With them the sweet stock proves more hardy than the sour, enduring drought better and making a better growth under similar conditions. There is but one drawback to the general use of sweet stock on that class of land in north and central Florida, but that is very nearly fatal at present. The disease variously known as Mal di Goma, foot rot, sore shin, and gum disease invariably appears in every orange-growing district where sweet stock is used. Trees on high dry land are less liable to its attacks than those on stronger or damper lands, but no district depending on sweet stock can hope to be free from the disease for any considerable length of time. In the orange-growing districts of Europe it has compelled the almost total abandonment of the sweet stock, and in California, under the name "gum disease," it is beginning to cause alarm. In a number of localities in Florida this disease has not yet appeared to any extent, and from these the greater number of the replies favoring sweet stock come; but, on the other hand, there are many reports from growers who planted sweet stock trees, believing that their locality would be exempt, only to see them die soon after they reached a good bearing age. The subject of Mal di Goma will be discussed under a subsequent heading.

The question of sweet or sour stock is not so much one of relative vigor as of the grower's willingness to run the risk of Mal di Goma, and opinions vary according to soil conditions. Replies to inquiries on the subject indicate that sweet stock is favored by only about 17 per cent. of those who grow the fruit on flat woods or poorly drained high pine land, and by only about 3 per cent. of those whose trees are on hammock or other rich, damp land. This shows that sweet stock is not favored by the majority of growers.

SOUR STOCK.

The origin of the various species and subspecies of *citrus* is very difficult to determine, but Galesio proves beyond doubt that the sour orange (*Citrus bigaradia*) was cultivated in Europe about the middle of the fifteenth century, long before the sweet orange was known there.

At that time, and indeed for nearly two centuries, it was popularly supposed that the sweet orange could be propagated only by grafting, and for this purpose the bigarade stock was almost universally used. It was quite natural, therefore, that the Spaniards at the time of their first settlement of Florida should have introduced the sour orange into that country. Perhaps no plant has ever been naturalized so rapidly and successfully as the orange tree. Indeed, did not the original narratives of the Spanish discoverers of these regions and the testimony of contemporary historians prove that this treasure was received from Europe, it would surely be regarded as indigenous to American soil.

In Florida the sour orange is found wild only in the hummocks. There it seems to delight in the rich, moist soil, and it is on this kind of land that its value as a stock is most apparent. While it does well on the better class of high pine land, especially when well cared for, it is never so vigorous as on stronger land. Its great point of value is its freedom from disease, and it is upon this one claim that its popularity is generally founded. Upon high pine land in Florida about 40 per cent. of the growers are found to favor sour orange stock against 30 per cent. who favor sweet, and 30 per cent. who are divided in their choice between rough lemon, pomelo, bitter sweet, lime, or who have no choice. On the flat woods near 70 per cent. favor sour orange stock against 17 per cent. who favor sweet, while on the hummocks fully 90 per cent. of the replies have been favorable to sour orange stock against 3 per cent. for sweet stock, including seedlings. Of the famous Indian River groves fully 99 per cent. are founded on sour stock.

In some localities in Florida, notably in Orange and Volusia Counties, it is claimed that drought is less injurious to sour than to sweet stock, and there may be some foundation for this opinion, owing to the relatively slower growth of the sour stock on sandy land, but the claim is not general. Its claim for superior resistance to frost is much more widespread, and despite some contradictory evidence, which may perhaps be due to local causes, we must accept it until more accurate comparative experiments are made. The California returns are decidedly corroborative of this claim.

In the nursery the sour seedlings are apt to become infested with leaf-scab to a considerable extent, which often causes serious loss. No critical study of the disease has yet been made, but it is clearly fungous in its origin, and until such study can be made it might be well to experiment with the ammoniacal fungicides which have proved so efficacious in pear leaf blight and apple scab. Once budded, all danger is over, the sweet top being quite proof against the disease. Lemon leaves and fruit are, however, subject to it.

Upon the subject of sour orange stock Mr. M. E. Gillett, of South Lake Weir, Florida, writes the Pomologist as follows:

This subject is one of vital importance to orange growers. All European countries years ago discarded the sweet root as a stock to bud or graft, and use the sour almost exclusively. I have been in the nursery business for some years, and have grown

many thousands of trees, have also charge of large grove interests here. One grove on heavy hummock land is about gone with gum disease. Out of 1,200 to 1,500 trees we have lost at least one-half, but have replanted all with others on sour roots, many of which are 5 years old and bearing, and show no sign of any foot rot. Another grove near here has lost every sweet stock (almost 600). All were replanted with sour stock 6 years ago, and are doing well. On a high pine grove, 80 feet above Lake Weir, we have lost several large sweet seedlings from same cause, though we have a remedy* which checks it on high land. On the low, heavy land, attacked trees always die. We have been shipping about 150,000 trees per year for the past 3 years to California, and from our experience we have contended all along that the sour stock was in many particulars the better stock. I learn that they have foot rot in California quite bad in some places, but in the face of it all there are a number of California nurserymen who have trees on sweet stock who will argue against the sour orange root. My experience with the two has been large, and the sweet seed is easier to get and cheaper, but for many reasons we always get the sour. We believe they are longer lived, hardier, more thrifty, and will stand more exposure than the sweet. In the Speer grove at Sanford the old seedlings are dying apparently from old age, while sour stock planted at the same time are beautiful old trees. I never knew a case of gum disease on a sour tree in the wild groves or on those that were transplanted, though sometimes when a tree is bruised it will gum, especially in hot weather, but it soon heals.

ROUGH LEMON STOCK.

Within the past few years a new stock, combining most of the good points of the sweet and sour stocks, has come into prominence, especially on the flat woods and scrub lands of the southern citrus belt of Florida. This is the "French" or "Florida Rough" lemon, which has been grown from time immemorial in Florida and the West Indies, and seems to correspond almost exactly in tree, flower, and fruit with Hybrid XXV (citroned orange, *citrus aurantium indicum*, *citratum fructu magno*, *cortice auro*, *crasso*, *amaricante*, *medulla acid et arma*) of Gallesio; it is also closely related to the Pomo d'Adamo citron, and partakes of the nature of the citron, lemon, and orange. The tree has escaped from cultivation and become naturalized in some parts of south Florida, where the hummocks contain numbers of bearing trees growing luxuriantly in the midst of thick underbrush and forest trees. It is very valuable for home use, though not for shipping; the fruit hangs on the tree in fair condition until the new crop is large enough to use, and is very healthful and refreshing in the raw state.

As a stock for the orange and lemon it is becoming favorably known all through south and central Florida, although in the northern part of the State the pomelo may prove a trifle hardier. Either stock should be budded as near the collar as possible as a safeguard against frost. Upon its value Reasoner (Pom. Bul. No. 1, p. 76) remarks:

The rough lemon is most desirable on poor land or on low and wet land, as it succeeds better than any other stock in such locations, being a free, rampant grower, not particular as to location.

* To be found under head of "Mal di Goma."

This statement, in fact, summarizes the whole subject. The rough lemon does not take the natural place of the sour orange stock for hummock or other strong soils, but it is practically as free from Mal di Goma, and is considerably more thrifty than sweet stock upon high pine land, at the same time doing well on wet flat woods, underlaid with hardpan. Its practical value upon sandy soil is indicated by the fact that 45 per cent. of the growers in south Florida favor it for high pine, 50 per cent. for flat woods, and 8 per cent. for hummock. On hummock the sour orange stock holds its own, 84 per cent. of the replies favoring it for that class of land.

POMELO STOCK.

In habit of growth and thriftiness the pomelo much resembles the rough lemon and practical trial has proved it a good substitute for sweet stock on high pine land in the northern citrus belt of Florida. It is more vigorous in growth than the sweet seedling on this class of land, and while it does not gain favor on flat woods or hummock, yet it is reputed to be considerably more hardy than the rough lemon, and may possess all the advantages of that stock on dry, sandy land. Among the reports furnished this office not over 3 per cent. of the writers have a large number of trees on this stock, but a much larger proportion pronounce in its favor.

OTHER STOCKS.

Several other species of *Citrus* have been used as stocks for the orange, among which may be named the lemon, lime, China lemon, bitter sweet, citron, and trifoliata. The sweet lime, especially, is much esteemed as a stock in India, and the Florida lime stock promises to extend the southern limit of profitable orange culture. None of them, however, are of great practical importance for grove culture in the United States. The lemon is too susceptible to gum disease, the lime and citron lack resistance to cold, the China lemon, commonly propagated from cuttings, soon loses thrift and dies, the bitter sweet is not so thrifty as the sour orange, and the trifoliata is a hardy dwarf stock for indoor use, or for dwarfing the Satsuma. Upon this stock the Satsuma is hardy as a garden tree beyond the usual limits of orange culture, but its value has been greatly exaggerated, especially in Texas, where it has been advertised as able to stand a zero temperature. A Satsuma, Kumquat, Mandarin, or Tangierine on trifoliata stock makes a compact and highly ornamental house plant which bears good crops in 3 or 4 years from the time of budding.

ORANGE STOCKS IN FLORIDA.

Per cent. of growers favoring each kind of stock on high pine, flat-woods, and hummock land, by districts:

Kind of stock.	Northern citrus district.			Central citrus district.			Southern citrus district.		
	High pine land.	Flat woods.	Hummock.	High pine land.	Flat wood.	Hummock.	High pine land.	Flat woods.	Hummock.
Sweet orange*	P. ct. 32	P. ct. 13	P. ct. 3	P. ct. 35	P. ct. 30	P. ct. 1	P. ct. 23	P. ct. 9	P. ct. 6
Sour orange	52	77	97	34	64	90	29	40	84
Rough lemon	2			11		4	45	50	8
Pomelo	2			3		1	1		
Bitter sweet	1								
No choice of stocks	11	10		17	6	4	2	1	2

* Sweet orange stock includes sweet seedlings.

SUMMARY AND RECOMMENDATIONS.

FLORIDA.

Northern citrus belt.—Upon high pine land, particularly of the second or third class, use pomelo or rough lemon stock, taking care to bud very low—as near as possible to the collar. The pomelo is decidedly the most hardy, comparing favorably with the sweet orange in this respect. If the grower is prepared to cultivate highly and perhaps irrigate, sour orange stock will be as satisfactory as any. Sweet stock should be used only after carefully weighing the risk from Mal di Goma; it will make large trees in less time than the sour, but not so quickly as rough lemon or pomelo, and will not bear so early or be so prolific. In planting sweet stock an excellent plan is to set it high, so that the crown roots may be more or less exposed to the light and air, thereby lessening the danger of disease.

For flat woods, especially when decidedly wet and underlaid with hardpan, the sour root is decidedly better than the sweet, and although both rough lemon and pomelo are more thrifty, their comparative tenderness renders them undesirable except where the benefit derived from thrifty growth is marked.

Upon hummock land sour stock is beyond all question to be preferred. Indeed, on such land no other should be planted.

Central citrus belt.—In this section the rough lemon root can be used with much more safety, but should be budded low, both as a safeguard against frost and in order to shade the trunk from the sun. Sour stock is not in so much favor as in the more northern counties, especially upon high pine land and flat woods. Upon hummock in this section the sour orange root is far superior to any other for a stock.

Southern citrus belt.—Upon high pine land, scrub, and flat woods use the rough lemon stock. In the South the superiority of this stock is

beyond question, and it does fully as well upon flat woods as upon drier land. Even in the hummocks it is superior to sweet orange, although the sour orange is much more satisfactory in the end, on that class of land anywhere in the orange-growing regions.

LOUISIANA.

Upon the rich alluviums of the Lower Mississippi and its delta, where all the large orange groves of Louisiana are situated, the sour orange stock is preferred by about 90 per cent. of the planters. In a few instances sweet seedlings have been used on the higher, gravelly lands with fair results, but the sweet stock as such is almost unknown, while danger from frost precludes the use of pomelo or rough lemon stock. Mal di Goma is a common disease among the sweet seedlings, under the name "sore shin."

The greater part of this orange region is liable to inundation for a month or more in the spring, as the river is above the level of the land and frequent crevasses occur. Nothing but the sour orange root can safely be used in locations subject to overflow.

CALIFORNIA.

The orange has held a leading place among the fruits of California ever since American occupation, but the question of stock has not been considered to be of particular importance. Within the past few years, however, the introduction and remarkable success of the wild sour orange stock (*C. bigaradia*) of Florida has opened up a discussion which will result in lasting benefit to the State. Certain nurserymen who have large interests in sweet stock at stake bitterly oppose the introduction of the sour orange, and endeavor to bias public opinion by making the term sour stock include all roots except that of the sweet orange, thus seeking to make the condemnation which all California growers award to the lemon, China lemon, lime, etc., as stocks cover also the sour orange stock. The injustice of this is manifest and can but work injury to those employing such means.

The deep rich alluvium, formed from granite and limestone and underlaid by a retentive subsoil and sufficient surface irrigation, form a combination of conditions to which the sour orange is peculiarly well suited.

From data sent this office by California orange growers who have tried the sweet and sour orange stocks side by side on a large scale it is safe to conclude:

1. That the sour stock trees make a more thrifty growth;
2. That they are more free from disease and are entirely resistant to Mal di Goma (foot rot or gum disease);
3. That they are less liable to be injured by cold while young;
4. That the quality of the fruit is not impaired.

It seems high time for the California nurserymen to import sour orange seed and grow their own sour stock, which would then be much more satisfactory than the sour seedlings now brought from Florida by the carload.

The great value of the Florida rough lemon as a stock in Florida has led to some inquiry as to its probable value in California. No extended experience has been had with it in the latter State, and no positive opinion can be given, but its remarkable thriftiness and precocity of bearing make it worthy of full trial. It is considerably more sensitive to frost than the sweet orange, and should invariably be budded low. If it proves desirable in other respects it may be safely used wherever the lemon succeeds commercially. It is entirely free from Mal di Goma in Florida.

As an indication of the present status of the sweet and sour orange stocks in California, extracts from the reports of several representative growers are appended :

My ranch is on the northern border of the valley of San Bernardino, near its eastern extremity. It is in the valley proper, and at the base of the foothills by which it is bounded on the north and east, and has an altitude of 1,250 feet. The location is such that the cold air comes down from the San Bernardino mountains at night, displacing the warm accumulations of the day, which rise to the foothills, assuring them safety from frost during the night. This is at the expense of the lowlands, which suffer from the extreme changes of temperature. The soil is a rich, sandy loam, well irrigated. Manifestly, the abrupt changes in temperature to which I have alluded, while perhaps not sufficient to kill the tree, are not for its good, and if there is any difference in the sweet and sour stocks in ability to withstand these changes, it will be found in the superior vigor and vitality of the one over the other.

Early in 1886, I procured from relatives at St. Mary's, Ga, 40,000 reliable sour orange seed, which I planted and subsequently budded to Washington Navel. In May, 1890, I transplanted about 1,100 in orchard form. In 1888, on my ranch, four-year old buds on sweet stock were frozen to the collar. Within the past few days the 1,100 trees spoken of have been subjected to the lowest temperature I have ever known on my farm, and in no instance have they suffered. Fresh growth is nipped in cases only. The registers were for January 10, 6:30 a. m., 24° above zero; for 11th, 23°; and for 13th, 21°. Within 10 feet of one row of these trees, ice formed one-half inch thick.

I have never seen anything in sweet stock comparable with the wealth of roots on my sour stock. The tops have grown even more luxuriantly. By reason of this and my experience of the low temperature of the past few days, I am pleased to have this opportunity to testify as to the performance of the sour stock and to venture the opinion, based upon the experience in 1888, that the sweet stock trees would not have survived.

Permit me to refer to the prejudice which exists here, fostered by our local nurserymen, against sour orange stock, and to recommend the procuring and planting of the seed in all cases. * * * Whole orchards have been lost by planting Florida grown trees which were poorly packed, and frequently kept out of the ground for months.—H. J. QUINAN, Messina.

I have planted during the last 3 years about 90 acres of orange and lemon trees, of which about 75 acres were on sour stock (Florida wild orange), budded to several varieties, the remaining 15 acres being sweet seedlings. * * * These trees have done well, making excellent growth and keeping in healthy, vigorous condition. They have been subjected at various times to several degrees of frost, 26° once or

twice, 28° probably several times, and many nights cold enough to form ice on standing water, and without any serious wilting or apparent injury. The sweet seedlings have made a larger growth than any of the budded trees planted at the same time (1888) except the lemons, budded on sour orange stock, which have grown very heartily indeed and are now bearing. * * * In my old orchard of Tahiti seedlings there are perhaps sixty trees of Mediterranean Sweet on sweet stock, averaging 10 years old. They grow heartily and bear well, but show more sensitiveness to frost than my young trees, many of the leaves wilting and turning white after a cold night.

One thing more may be worth mentioning as bearing on the question which has been raised as to whether the sour root could impair the flavor of the fruit of budded trees. On my Washington Navels, planted in 1888, I had in February and March, 1890, perhaps two boxes of perfect fruit. The flavor of these oranges was very superior; they were sweet, and of very lively flavor, and certainly showed no bad effect from the stock. I had made a similar observation in Riverside 2 years before, on eating oranges grown on sour stock in the orchard of Mr. Bliss. They were the best Navels I found in Riverside at that time, being a little riper, owing to some earlier or heartier habit of the stock.—E. S. THATCHER, Nordhoff.

My investigations commenced in 1885 and have been faithfully followed up to date. Previous to 1885 all the orange trees in California were on sweet stock, the sour orange stock being unknown, hence a sweeping interest lies in sweet stock. My own orchard was on sweet stock, but wherever I have lost trees I have set sour stock. Among my oldest trees I have been fighting "gum disease" for 5 years. In some cases I have succeeded in overcoming it by cutting away the diseased wood and bark and painting with strictly pure "rubber paint" to exclude the air. I have always irrigated in furrows, allowing no water near the trunk of the tree, and have kept the ground loose by cultivation. I can see no reason for "gum disease" except that it is characteristic of the sweet stock; have never heard of a case on sour orange stock. To-day I feel warranted in saying that were I putting out a new orchard, I would unquestionably use orange and lemon on sour orange stock.—D. C. TWOGOOD, Riverside.

Of the 70 acres I have planted only 10 acres with trees on sweet stock. When I made the change to sour stock, I made it mostly on the ground that I could get better rooted trees at a less price on the Florida sour stock than on home-grown sweet stock. I have now found that my trees on sour stock have made a better growth than trees budded on sweet stock.

Three years ago next spring I planted 10 acres of Washington Navels on sour stock. I was unable to get good sized trees for planting and was obliged to take trees from 2 feet to 30 inches high. On these trees there is about a box of oranges. In flavor, sweetness, and in all points that count to make a first-class orange, they are equal to the best fruit ever grown. Have had no trouble from "gum disease" up to date on either stock.—C. E. HARWOOD, Ontario.

Mr. J. E. Cutter, of Riverside, also gives the following interesting statement:

Amount of land, 10-acre lot; soil, red granitic mesa; depth to surface water, about 150 feet; date of planting, April-May, 1887; stocks used, Bigaradia (sour orange); size of stocks used, one-half to five-eighths inch diameter at base. [These small stocks had just been brought from Florida.] Date of budding, October, 1889. [Some rebudding in April, 1890.] Average diameter at base when budded, 2 inches; average diameter at point of inserting bud, 1½ inches; average height of point of inserting bud, 2 feet 8½ inches; average height of trees, December 25, 1890, 10 feet 8¼ inches; average growth of buds, season of 1890, 8 feet three-tenths inch; maximum growth of single bud, 12 feet 1 inch.

This is by actual measurement, and Mr. Cutter further states that the condition of his trees is the "best of any grove I have ever seen."

MAL DI GOMA.

Foot rot, gum disease, sore shin, etc.

A number of years ago a mysterious disease of the orange made its appearance in Florida, and subsequently in Louisiana and California, which has since baffled, to a considerable degree, all efforts to learn its exact nature or to effect a permanent cure. Investigation developed the fact that the same disease had long been known as Mal di Goma in southern Europe, where it caused the loss of millions of dollars' worth of orange and lemon groves, and that it first appeared in the Azores about fifty years ago, and upon the Continent of Europe ten years later.

CHARACTERISTICS OF THE DISEASE.*

The disease, as a rule, is first made manifest by the appearance of a gummy effusion which appears, principally in the spring and autumn, on the trunk of the tree close to the ground, or directly upon the root. Even before there are any outward signs of diminished health, small drops of gum appear on the bark of the trunk; these increase in size and number and the bark appears to melt away or become honeycombed; finally, the gum liquefies and assumes a muddy brownish color and a disagreeable odor. In winter or summer when the effusion of gum decreases or stops the greater part of the bark around the point of infection dies and becomes detached from the wood. When dry it springs away from the wood and becomes hard and brittle. The surface of the wood underneath the bark is also affected to some little distance in all directions from the point of infection. The most vital part of the trunk, the cambium layer, which lies between the bark and the wood, is partially destroyed, and each year this destruction extends until it finally girdles the tree completely, thus cutting off all communication of the vital fluids between the root and the top, and causing the death of the tree.

When the disease attacks the roots the death of the tree follows more rapidly—often in less than a year. The sudden changing of the leaves to a sickly yellow color is the first visible symptom of the disease when the roots are attacked. It must be kept in mind, however, that the leaf-yellowing may be due to other causes.

CAUSE OF THE DISEASE.

The cause of Mal di Goma is not certainly known at present, but, contrary to the general supposition, indications point to a bacterial rather than a fungous origin. It is true that several species of fungi are found on the diseased parts, but these are believed to be saprophytic in their nature rather than parasitic.

Various theories as to the cause of the disease have been advanced—improper drainage, "wet feet," growing over hardpan, improper fer-

* Extract from Bulletin No. 8, Division of Vegetable Pathology.

tilizer, unsuitable soil, irrigating too close to the tree trunk, excess of ammonia, setting too low, etc.—but none of them hold good except in individual instances.

TREATMENT SUGGESTED.

The disease is a dangerous one to experiment with, and except in unusually well drained location the tree had better be immediately dug up and burned, root and branch. It is even dangerous to dig about healthy trees with the same implements used to dig about diseased trees unless they are disinfected with carbolic acid. Positive evidence exists that the disease has been conveyed from tree to tree in this way, by a sort of accidental inoculation. As an aid in preventing or checking the ravages of the disease, growers are advised (1) to bud on resistant stocks—wild sour orange, rough lemon or pomelo; (2) to plant on dry and porous soil if sweet stock is used; (3) to irrigate sparingly and keep the water from the trunk of the tree; (4) to cut out every trace of diseased wood and bark when the malady appears, and burn the part cut out.

Secretary B. M. Lelong, of the California State Board of Horticulture, recommends that the wound be painted over with pure rubber paint, after the diseased wood has been removed. Mr. M. E. Gillett, of Florida, gives the following receipt for a treatment which he has found reasonably effective upon high pine land:

The remedy I have used is composed of the following ingredients: One peck fresh stone lime, 4 pounds copperas, 5 pounds sulphur, 1 gill crude carbolic acid. Put these in a barrel and add enough water to slack the lime, cover and let it stand until cool, then fill the barrel with water and stir well. The mixture is then ready for use. All the diseased bark and wood should be carefully cut away, and the wash applied with a brush. While the preparation does not always cure, it has checked the trouble, and trees that I have experimented upon seem to be doing well.

This, and other remedies we have seen, seem to be disinfectants rather than fungicides, but the addition of sulphate of copper may be an improvement, and is certainly a step in the right direction. Washes having bisulphate of soda and carbonate of lime as a base would probably be of some value, and are worth experimenting with.

MUTUAL INFLUENCE OF STOCK AND SCION.

While the prime object of grafting or budding is to perpetuate the characteristics of an individual plant, or to propagate a variety, physiologists tell us that the vigor and fertility of the scion are affected more or less by the operation. The pear grafted on quince roots is dwarfed, but on Kieffer pear roots is made much more vigorous. On the principle that the vigorous growth of the tree is at the expense of its fruitfulness, and on the other hand that prolificacy interferes with vigorous growth, working a strong growing scion upon a weak root will bring the tree into bearing at an early age. But why the stock should hasten or retard

the period of ripening, or how it changes the color, flavor, or size of the fruit, is not so easily shown. We know that a number of the superb foreign varieties of the pear can only be grown successfully by us on quince roots; the Angouleme and Louise Bonne are notable examples of this, being generally conceded to be of decidedly higher quality upon the quince, but on the other hand the Seckel needs all the vitality of a thrifty stock to reach its greatest perfection.

All we know about the phenomenon of dwarfing is that the quince stock gives out a more meager supply of sap, so affecting the growth of the tree that it is stunted in its growth of wood and thus brought into bearing at an earlier age and made to produce larger and more certain crops of perfect fruit, but the want of complete harmony between stock and scion has a tendency to shorten the life of the tree. A good example of the ordinary effect of stock upon scion may be found in nursery practice: a promiscuous lot of seedlings is raised and upon these roots some particular variety is worked; all may be planted at the same time and under exactly similar conditions, but a season's growth will develop a marked variation in individual vigor, which can hardly be laid to any cause except variation in the vigor of the different seedlings. Indeed, this difference in thriftiness, owing to variation of stock, is a matter of commercial importance, determining to a large extent the several grades into which nursery trees of any given variety are assorted.

Considered from a theoretical point of view no influence, as far as the flavor of the fruit is concerned, is to be expected. The ascending sap, which is furnished by the root or stock, is nearly a simple fluid. The leaves digest and modify this sap, taking carbonic acid from the air and forming the sugar compounds and sap proper. The leaves of a grafted tree are the leaves of the particular variety cultivated, and have no physiological connection with the root grafted upon. Every bud, leaf, and fruit upon a branch maintains its individuality by preparing its own proper nourishment out of the general supply of the sap. Each separate cell of the inner bark has this power of preparing food according to its nature. In proof of this De Candolle (*Physiologie Végétale*) cites an instance where rings of bark, of closely allied species, were grafted one above another on the same tree; no buds were allowed to grow, but when the tree was cut for examination, characteristic wood of each species was found deposited under its respective ring.

Though the stock increases in size by woody matter derived from the sap elaborated by the leaves, its character is not perceptibly changed; a sprout from below the point of union always being characteristic of the original stock. Proof that the graft may communicate disease to the stock is, however, abundant and beyond question. Yellows of the peach has been propagated thousands of times by budding, and the stock and bud die together from its effects. The same may also be

said of blight in the pear. The phenomenon of variegation, which is now classed as a form of disease, gives an excellent example of the power of the scion to infect the stock, variegated leaves frequently appearing upon the stock below the point of union and sometimes even as stolons from the root. On this point Burbidge (*The Propagation and Improvement of Cultivated Plants*, p. 61) gives some very interesting details. In some instances the *habit* of root growth is influenced to a marked degree, an upright top inducing deep rooting, and a spreading top being always accompanied by good lateral roots.

A strong root produces a strong top growth, and while the top remains and expands the root extends in the same ratio. When, however, we cut off the vigorous top and substitute a weaker, the root is, to a great extent, paralyzed, even though it induces a strong temporary growth. It can never do more than respond to the weaker growth grafted upon it, and in the end the graft becomes just as weak as if it had been upon its own roots. In this relation, however, recent experiments incline us to the belief that far greater benefit may result to a weak scion if a portion of the original vigorous stem and foliage be allowed to remain, thus preserving nearly the whole vigor of the root. In a limited way a weak variety might advantageously be grafted with stronger ones at both ends by the practice known as double grafting.

To summarize our present knowledge of the whole subject we may say that a strong growing variety is dwarfed by union with a weaker stock, while a weak scion is not *in the end* benefited by grafting in the ordinary manner upon a stronger stock. In either event the flavor and quality of the fruit is only affected in proportion to the thriftiness of the tree's growth, the natural flavor or character of the fruit of the stock having no influence whatever upon the fruit of the scion.

EXPLANATORY NOTE.

For the benefit of those who are not familiar with Florida, the terms "high pine land," "flat woods," "scrub," and "hummock" may be explained as follows:

High pine land.—A light-gray sandy loam, more or less rolling in surface, timbered sparsely with long-leaf pine and fairly free from undergrowth, except in localities where saw palmetto is abundant; generally underlaid with clay at a depth varying with the height of the land, and with a yellow sand subsoil. On the lower lands several species of scrub oak are found among the pines.

Flat woods.—Timbered like high pine, but generally has more saw palmetto; underlaid with hard-pan at a depth of 6 inches to 2 feet, and in the rainy season often flooded for weeks at a time.

Scrub.—Generally a bank of white or yellow sand, covered with a scant growth of a species of heath known as rosemary and thickets of scrub or spruce pine (*Pinus inops*), a species which grows on no other land. "Black-jack" scrub is generally not quite so barren as rosemary scrub.

Hummock.—A term applied indiscriminately to any land with hard-wood timber and dense undergrowth. The soil is generally much stronger than the best pine land, and lies on a lower level, although not always wet. Low hummock is often very close to the water level, but can not be called swampy, although frequently flooded in summer.